

FIG. 1

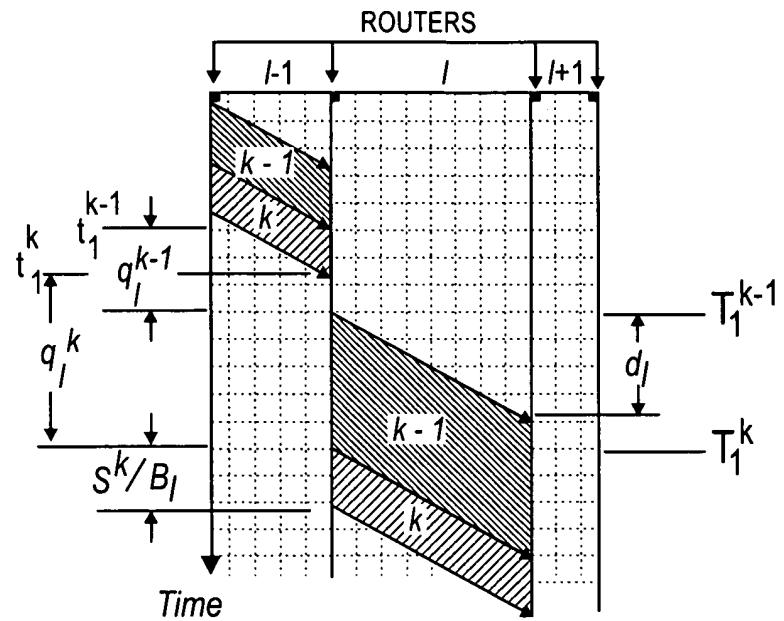


FIG. 2

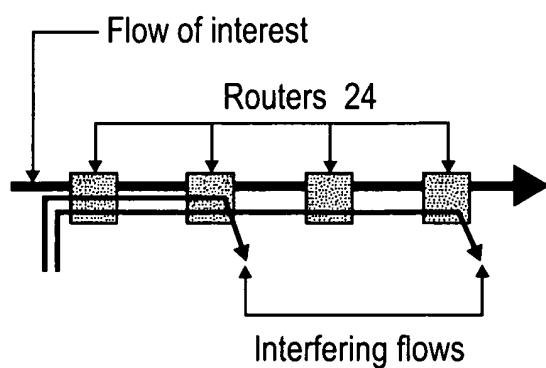


FIG. 3

Probe 1		Probe 2		Routers	
Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
$\sum_{i=0}^{l-1} q_i^{probe_1}$ $\hat{q}_i^{voice} + s^{probe_1} / B_i$ $i=0, \dots, l-1$	Max: $\hat{q}_i^{voice} + s^{probe_1} / B_i$	$\sum_{i=0}^{l-1} q_i^{probe_2}$	Max: $\hat{q}_i^{voice} + s^{probe_2} / B_i$ $i=0, \dots, l-1$	$\sum_{i=0}^{l-1} \hat{q}_i^{voice}$	$\sum_{i=1}^{l-1} \Delta q_i^{voice}$

FIG. 4

Router (l)			
Forward	\hat{q}_l^{voice}	$q_l^{voice}_{previous}$	Δq_l^{voice}
Reverse	\hat{q}_l^{voice}	$q_l^{voice}_{previous}$	Δq_l^{voice}

FIG. 5

	Probe Queueing Delay	Transmission Delay
Probe 1	$q_l^{probe_1}$	(s^{probe_1} / B_l)
Probe 2	$q_l^{probe_2}$	(s^{probe_2} / B_l)

FIG. 6

Inferred From Probe 1		Inferred From Probe 2		Network	Network	
	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
Forward Collector	$\sum_{i=0}^{l-1} q_i \text{probe}_1$ $\hat{q}_i^{\text{voice}} + s^{\text{probe}_1} / B_i$ $i=0, \dots, l-1$	Max: $\hat{q}_i^{\text{voice}} + s^{\text{probe}_1} / B_i$ $i=0, \dots, l-1$	$\sum_{i=0}^{l-1} q_i \text{probe}_2$ $\hat{q}_i^{\text{voice}} + s^{\text{probe}_2} / B_i$ $i=0, \dots, l-1$	Max: $\hat{q}_i^{\text{voice}} + s^{\text{probe}_2} / B_i$ $i=0, \dots, l-1$	$\sum_{i=0}^{l-1} \hat{q}_i^{\text{voice}}$ $i=0, \dots, l-1$	$\sum_{i=0}^{l-1} \hat{\Delta q}_i^{\text{voice}}$
Reverse Collector	$\sum_{i=0}^{l-1} q_i \text{probe}_1$ $\hat{q}_i^{\text{voice}} + s^{\text{probe}_1} / B_i$ $i=0, \dots, l-1$	Max: $\hat{q}_i^{\text{voice}} + s^{\text{probe}_1} / B_i$ $i=0, \dots, l-1$	$\sum_{i=0}^{l-1} q_i \text{probe}_2$ $\hat{q}_i^{\text{voice}} + s^{\text{probe}_2} / B_i$ $i=0, \dots, l-1$	Max: $\hat{q}_i^{\text{voice}} + s^{\text{probe}_2} / B_i$ $i=0, \dots, l-1$	$\sum_{i=0}^{l-1} \hat{q}_i^{\text{voice}}$ $i=0, \dots, l-1$	$\sum_{i=0}^{l-1} \hat{\Delta q}_i^{\text{voice}}$

FIG. 7

	Probe 1	Probe 2
Departure Time (From AR)	$T_{\text{probe}_1 \text{AR}}$	$T_{\text{probe}_2 \text{AR}}$
RTT (Round-Trip Time)	RTT_{probe_1}	RTT_{probe_2}
Arrival Time (At Correspondent Node)	$t_{\text{probe}_1 \text{CN}}$	$t_{\text{probe}_2 \text{CN}}$
Departure Time (From Correspondent Node)	$T_{\text{probe}_1 \text{CN}}$	$T_{\text{probe}_2 \text{CN}}$
Arrival Time (At AR)	$t_{\text{probe}_1 \text{AR}}$	$t_{\text{probe}_2 \text{AR}}$

FIG. 8

Delay (Δ)	$\tau_{total} = \tau_0 + \tau_1 + \dots + \tau_{l-1}$
Jitter ($\Delta\tau$)	$\Delta\tau_{total} = \sqrt{(\Delta\tau_0)^2 + (\Delta\tau_1)^2 + \dots + (\Delta\tau_{l-1})^2}$
Bandwidth (B)	$B_{total} = \{\min(B_i); i = 0, \dots, (l-1)\}$
Packet Loss (L)	$L_{total} = 1 - [(1 - L_0) \times (1 - L_1) \times \dots \times (1 - L_{l-1})]$

FIG. 9

Phase 1: End-to-end QoS Estimation					
	Router Monitoring		Probing	Processing	L2+L3 Combining
	Queuing Estimate Updating	Jitter Estimate Updating			

Phase 2: AR/AP Selection					
	QoS Ranking		QoS Classification	Load Balancing	Cost- Awareness
	Weighting- Based	Perception- Based			User Preferences

FIG. 10